Tanta University

Department: Computers Engineering and Automatic Control
Total Marks: 90 Marks

Faculty of Engineering

Course Title: **Signals and Systems**	Course Code: CCE2210	Year: 2nd Comp.
Date: May 30th, 2013	Allowed time: 3 Hours	No. of Pages:

Remarks: You must show all of your work -- partial credit may be given to partially correct answers, while answers with no justification may not receive full points. Please attempt all questions.

Problem (1) **(35 Marks)**

a) For the block diagram given in Fig.1

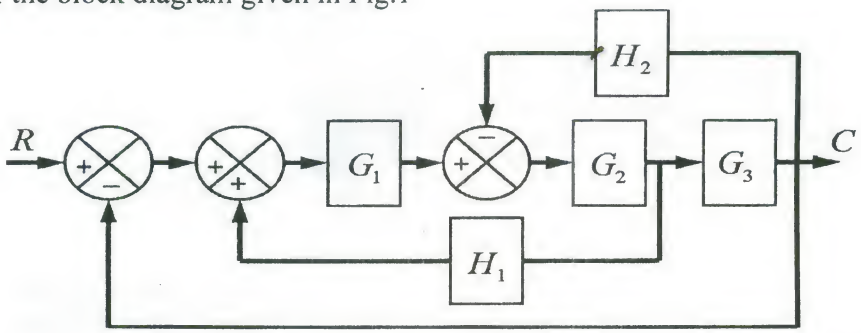


Fig. 1: Block diagram of problem 1-a

i- Using block diagram reduction rules, find the system transfer function (10 Marks)
ii- Check your answer using signal flow graph technique (10 Marks)

b) The state-space representation of a satellite system is given by:

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 0 & 1 \end{bmatrix} x(t)$$

i- Find the system transfer function (5 Marks)
ii- Calculate the state-transition matrix Φ(t) (4 Marks)
iii-Check the system controllability and observability (6 Marks)

Problem (2) **(25 Marks)**

a) Discuss the stability of the closed loop system shown in Fig. 2 in terms of K and determine the value of K which results in critical stability. (10 Marks)

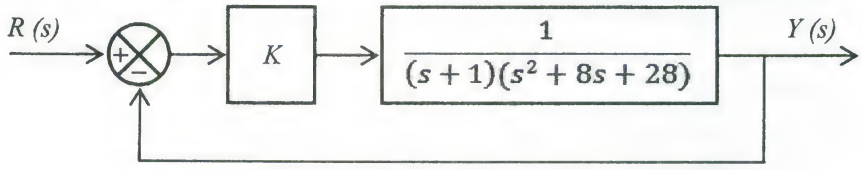
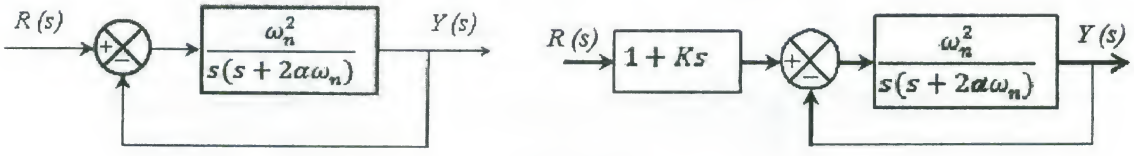


Fig. 2: Block diagram of problem 2-a

b) Consider the system shown in Fig. 3.



(a) (b)

Fig. 3: Block diagram of problem 2-b

i- For Fig.3-a, show that the steady-state error e_{ss} for unit ramp input is equal to $2\alpha/\omega_n$

ii- Show that e_{ss} is eliminated if the input is introduced to the system through proportional plus derivative element as shown in Fig. 3-b and the value of K is properly set. (10 Marks)

Problem (3) **(20 Marks)**

The electric equivalent circuit of the armature and the free-body diagram of the rotor of a DC motor are shown in Fig.4. The definitions of the physical parameters are:

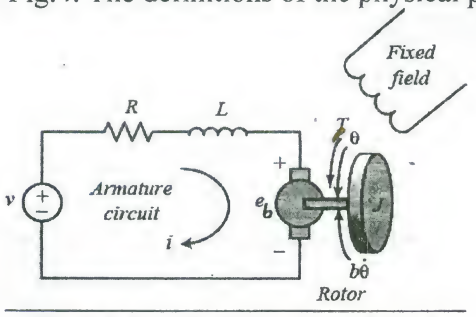


Fig. 4: Schematic diagram of problem 3

(J) moment of inertia of the rotor	(R) electric resistance
(b) motor viscous friction constant	(L) electric inductance
(K_b) electromotive force constant	(K_t) motor torque constant

i- Write the system equations and show that its block diagram representation is as in Fig. 5

ii- Drive a state-space representation using current, angular velocity, and angular position as the states of the system (10 Marks)

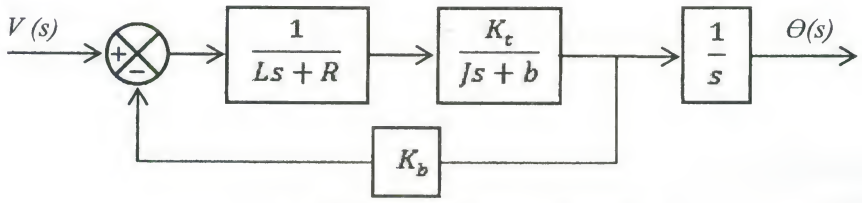


Fig. 5: Schematic diagram of problem 3-i

Problem (4) **(10 Marks)**

When the system shown in Fig. 6-a is subjected to a unit step input, the system output responds as shown in Fig. 6-b. Determine the values of K and T using the response curve and then find an expression for the output for unit step input.

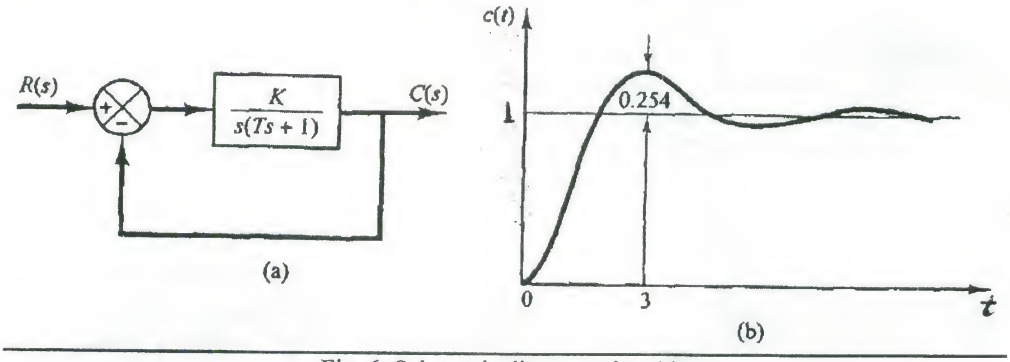


Fig. 6: Schematic diagram of problem 4

Good Luck

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